US009130196B2

(12) **United States Patent**
Lang et al.

(10) **Patent No.: US 9,130,196 B2**
(45) **Date of Patent: Sep. 8, 2015**

(54) **LIGHT-EMITTING COMPONENT AND METHOD FOR PRODUCING A LIGHT-EMITTING COMPONENT**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/348,906**

(22) PCT Filed: **Aug. 20, 2012**

(86) PCT No.: **PCT/EP2012/066203**

§ 371 (c)(1), (2), (4) Date: **Apr. 1, 2014**

(87) PCT Pub. No.: **WO2013/053517**

PCT Pub. Date: **Apr. 18, 2013**

(65) **Prior Publication Data**

US 2014/0264311 A1 Sep. 18, 2014

(30) **Foreign Application Priority Data**

Oct. 13, 2011 (DE) 10 2011 084 437

(51) **Int. Cl.**
H01L 51/52 (2006.01)
H01L 51/56 (2006.01)
H01L 51/00 (2006.01)

(52) **U.S. Cl.**
CPC ***H01L 51/5275*** (2013.01); ***H01L 51/524*** (2013.01); ***H01L 51/5268*** (2013.01); ***H01L 51/56*** (2013.01); *H01L 51/0031* (2013.01); *H01L 51/5246* (2013.01); *H01L 51/5253* (2013.01); *H01L 51/5278* (2013.01);

(Continued)

(58) **Field of Classification Search**
CPC . H01L 2251/558; H01L 27/283; H01L 27/30; H01L 27/3211; H01L 51/0001; H01L 51/0035; H01L 51/0036; H01L 51/0097; H01L 51/0516; H01L 51/5237; H01L 51/5262
USPC 257/40
See application file for complete search history.

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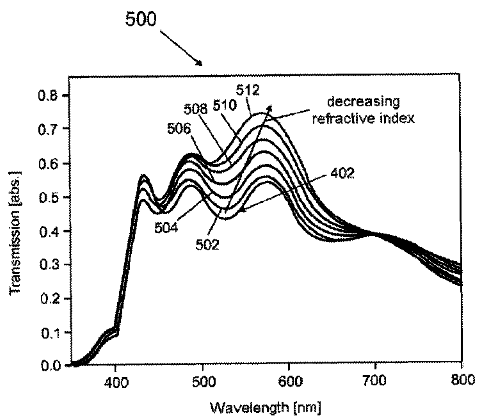
Primary Examiner — Stephen W Smoot
Assistant Examiner — Edward Chin

(57) **ABSTRACT**

A light-emitting component may include: an electrically active region, including a first electrode, a second electrode, an organic functional layer structure between the first electrode and the second electrode, a cover arranged above the electrically active region, and a layer structure arranged between the cover and the electrically active region. The component may have at least one layer having a refractive index which is less than the refractive index of the cover.

11 Claims, 8 Drawing Sheets



(52) **U.S. Cl.**
CPC *H01L 51/5281* (2013.01); *H01L 51/5296* (2013.01); *H01L 2251/5323* (2013.01); *H01L 2251/5369* (2013.01); *H01L 2251/55* (2013.01)

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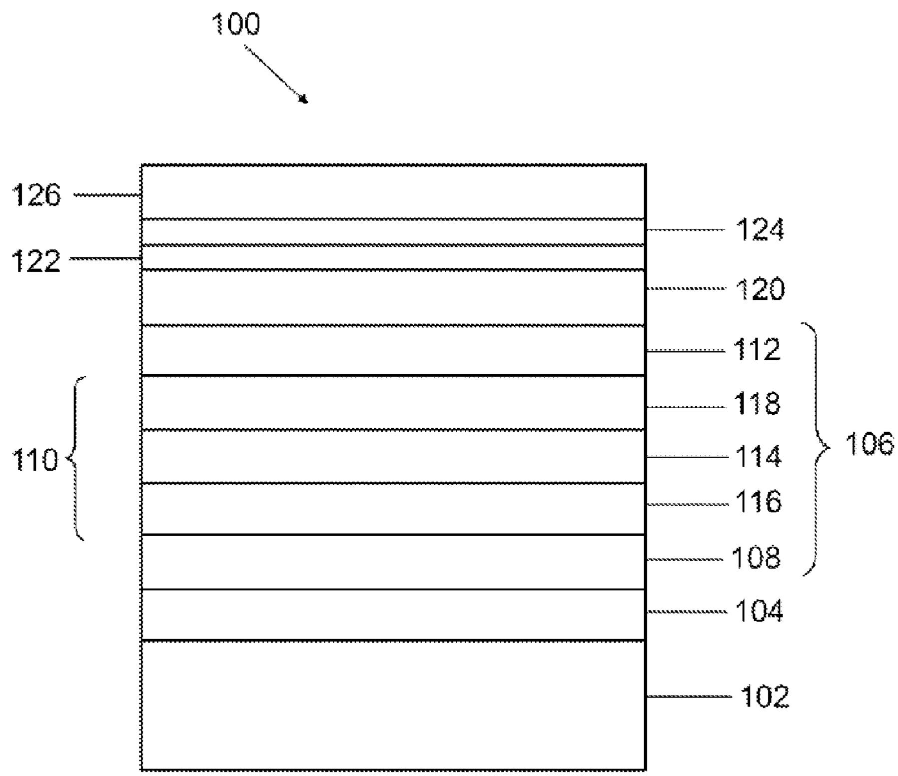

FIG 1

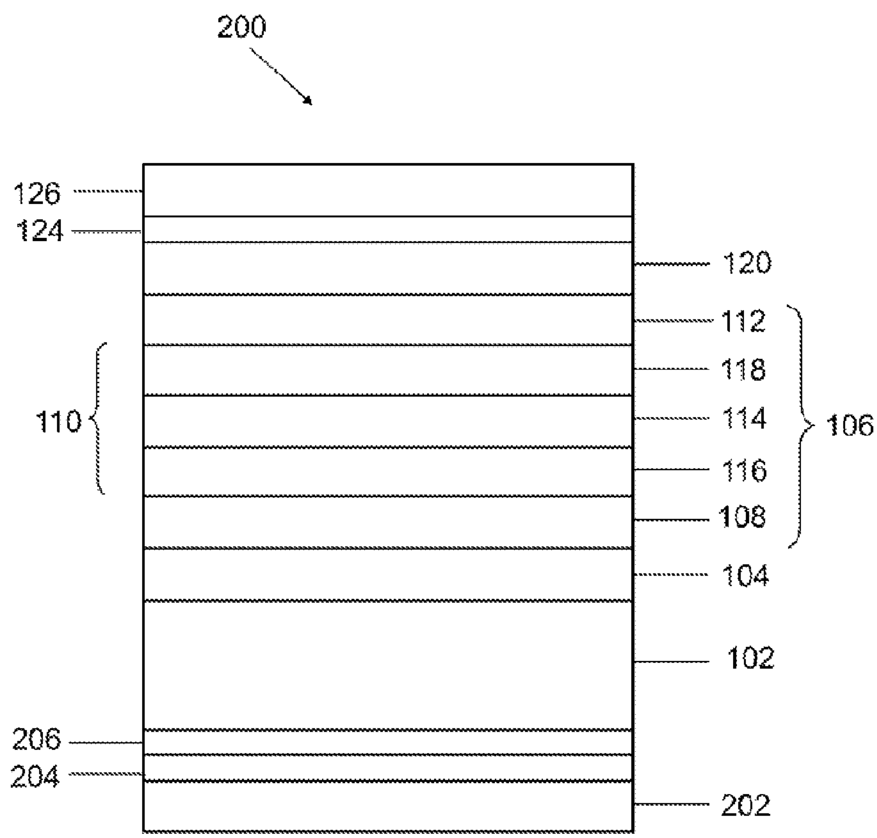

FIG 2

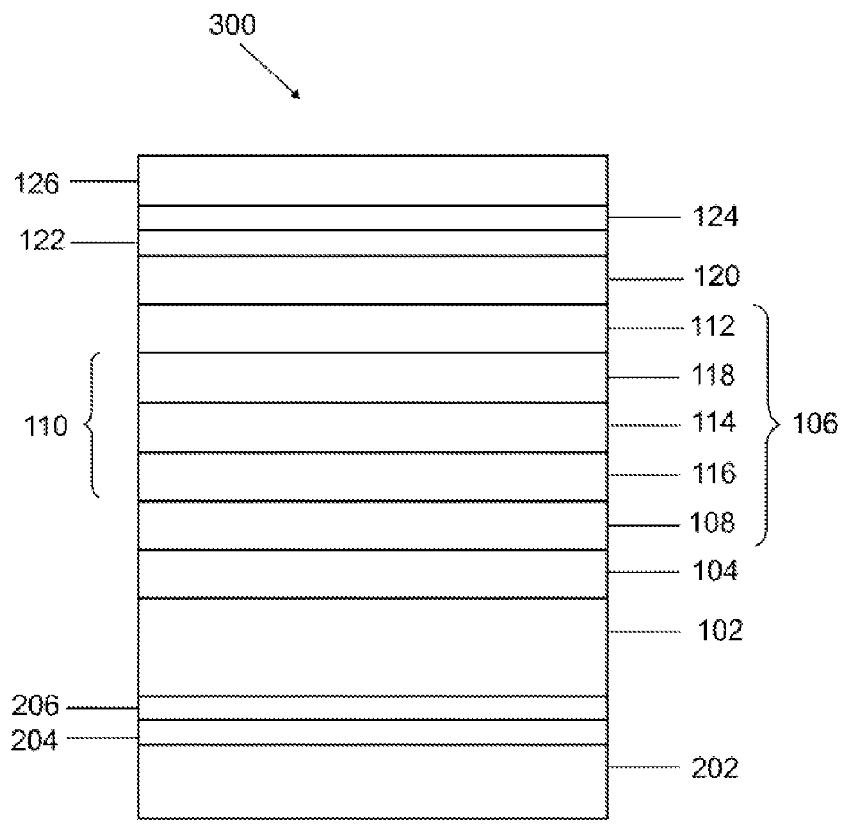
300
126
124
122
120
112
118
110
114
106
116
108
104
102
206
204
202

FIG 3

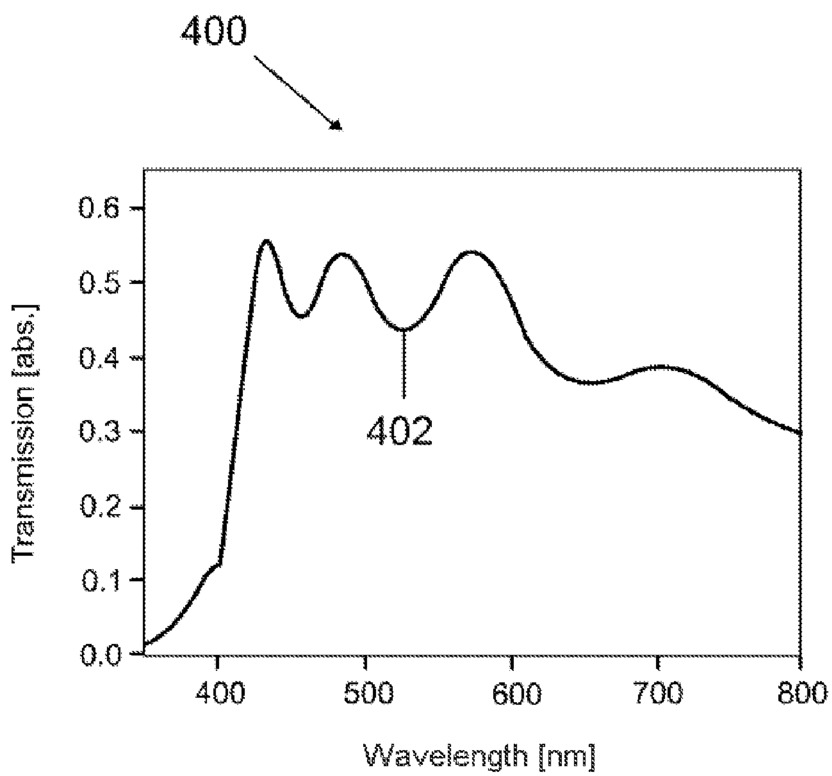
400
402
Transmission [abs.]
Wavelength [nm]
0.0
0.1
0.2
0.3
0.4
0.5
0.6
400
500
600
700
800

FIG 4

500

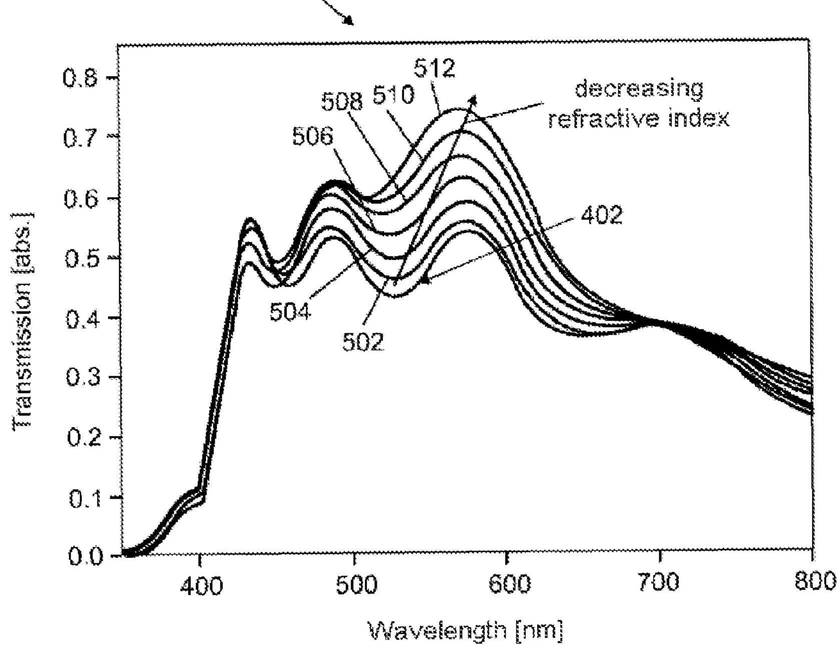
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Transmission [abs.]
400
500
600
700
800
Wavelength [nm]
512
508
510
506
decreasing
refractive index
402
504
502

FIG 5

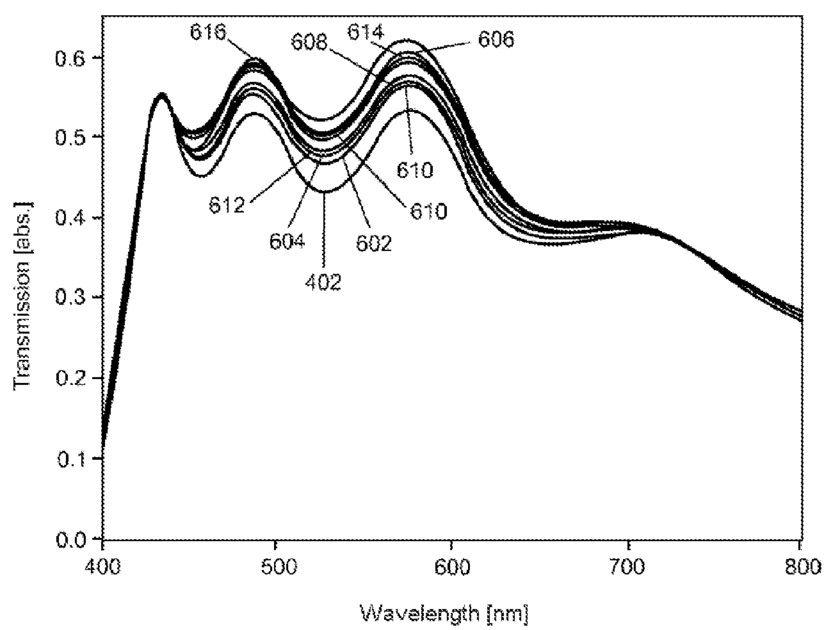
616
608
614
606
610
610
612
604
602
402
Transmission [abs.]
Wavelength [nm]
0.0
0.1
0.2
0.3
0.4
0.5
0.6
400
500
600
700
800

FIG 6

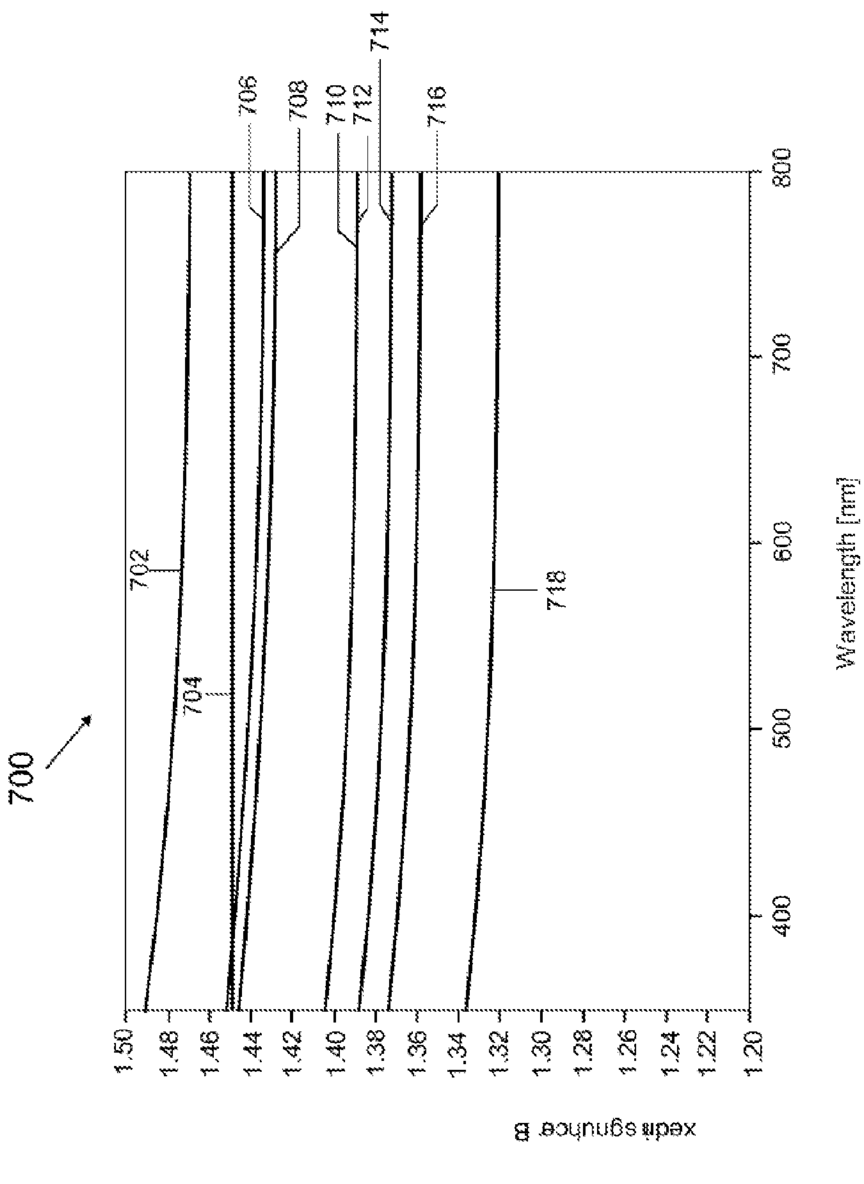
700
702
704
706
708
710
712
714
716
718
1.50
1.48
1.46
1.44
1.42
1.40
1.38
1.36
1.34
1.32
1.30
1.28
1.26
1.24
1.22
1.20
400
500
600
700
800
Wavelength [nm]

FIG 7

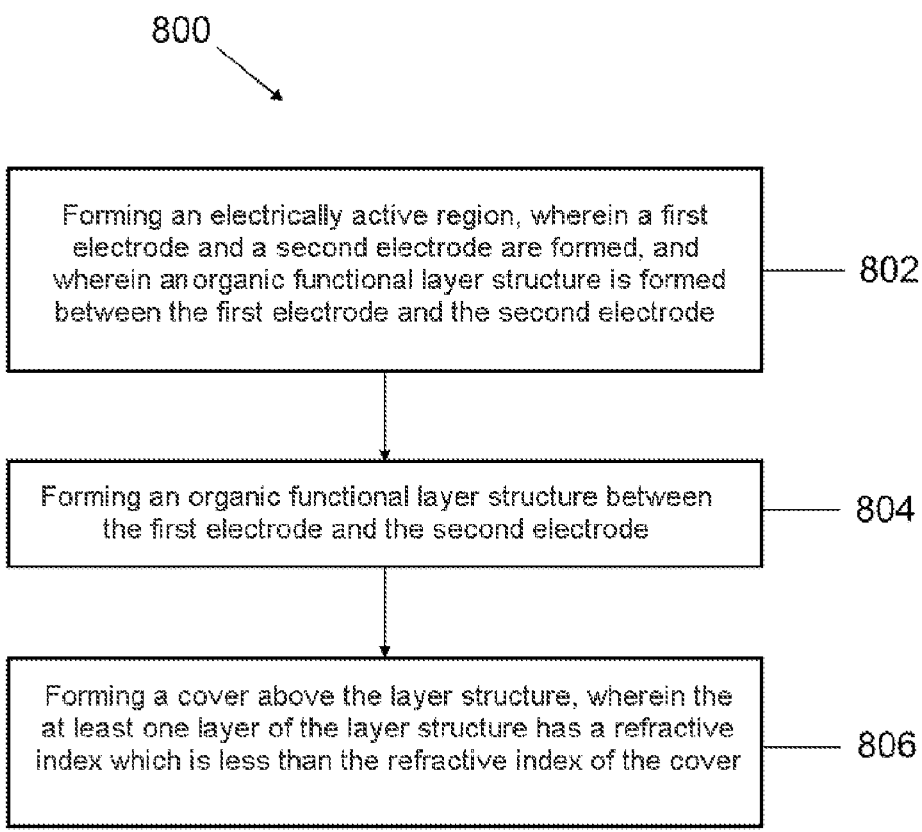
800
Forming an electrically active region, wherein a first electrode and a second electrode are formed, and wherein an organic functional layer structure is formed between the first electrode and the second electrode
802
Forming an organic functional layer structure between the first electrode and the second electrode
804
Forming a cover above the layer structure, wherein the at least one layer of the layer structure has a refractive index which is less than the refractive index of the cover
806

FIG 8

LIGHT-EMITTING COMPONENT AND METHOD FOR PRODUCING A LIGHT-EMITTING COMPONENT

RELATED APPLICATIONS

The present application is a national stage entry according to 35 U.S.C. §371 of PCT application No.: PCT/EP2012/066203 filed on Aug. 20, 2012, which claims priority from German application No.: 10 2011 084 437.6 filed on Oct. 13, 2011, and is incorporated herein by reference in its entirety.

TECHNICAL FIELD

Various embodiments relate to a light-emitting component and a method for producing a light-emitting component.

BACKGROUND

In a conventional transparent organic light-emitting diode (OLED) an adhesive having a refractive index of approximately 1.55 is usually used for the lamination of the cover glass. The achievable optical transparency of such a transparent organic light-emitting diode is limited.

SUMMARY

Various embodiments provide a light-emitting component in which a color adaptation of the light emitted by the component is achieved in a simple manner. Furthermore, various embodiments provide a light-emitting component in which the optical transparency of the component can be increased.

Various embodiments provide a light-emitting component, including: an electrically active region, including a first electrode, a second electrode, and an organic functional layer structure between the first electrode and the second electrode; a cover arranged above the electrically active region; and a layer structure arranged between the cover and the electrically active region and having at least one layer, wherein the at least one layer has a refractive index which is less than the refractive index of the cover.

Illustratively, the layer structure can be used in various embodiments, for example in an optically transparent light-emitting component, to put it another way in a top and bottom emitter, for example in a transparent organic light-emitting diode, wherein the layer structure in various embodiments may increase the transparency of the light-emitting component. This can be achieved in various embodiments without significantly increasing the total thickness of the light-emitting component.

In one configuration, the layer structure may include an adhesive or can be formed by an adhesive.

In another configuration, alternatively or additionally, the light-emitting component may include an adhesive between the cover (for example a glass cover, alternatively a film cover) and the at least one layer of the layer structure for fixing (for example laminating) the cover; wherein the at least one layer of the layer structure has a refractive index which is furthermore less than the refractive index of the adhesive. To put it another way, given the existence of an additional adhesive between the cover and the layer structure, the refractive index is for example both less than the refractive index of the cover and less than the refractive index of the adhesive. It should be pointed out that the cover can be, in principle, any arbitrary type of a cover, for example including any arbitrary type of one or more layers, for example including one or more lacquers or any other suitable layer.

In another configuration, the at least one layer of the layer structure can have a refractive index of less than 1.5. In various embodiments, the cover has for example a refractive index of greater than 1.5, for example of greater than 1.55, such that a distinct effect is already obtained in the case of a refractive index of the at least one layer of the layer structure of less than 1.5.

In another configuration, the at least one layer of the layer structure may include at least one fluoride or one fluorine-containing polymer.

In another configuration, the at least one layer of the layer structure may include a matrix having air inclusions or having particles which reduce the refractive index of the matrix.

In another configuration, the at least one layer of the layer structure may include aerogel or water encapsulated in the layer structure or in the light-emitting component.

In another configuration, the layer structure can have a layer thickness in a range of approximately 50 nm to approximately 150 nm, alternatively a layer thickness in a range of approximately 5 μm to approximately 50 μm. For these two layer thickness ranges, the best results were obtained with regard to increasing the transparency of the light-emitting component.

In another configuration, the light-emitting component may furthermore include a substrate and an encapsulation (for example a thin-film encapsulation), wherein the encapsulation is arranged on that side of the electrically active region which faces away from the substrate. The layer structure can be arranged above the encapsulation. By means of the encapsulation, the light-emitting component is protected even better against environmental influences such as moisture, for example.

In another configuration, the cover may include a first cover, which is arranged above a first main side of the electrically active region, and a second cover, which is arranged below a second main side of the electrically active region, said second main side being situated opposite the first main side. Illustratively, in various embodiments, on each main side of the light-emitting component, a respective cover, for example a glass cover, is provided for protecting the light-emitting component.

In another configuration, the light-emitting component can be designed as an organic light-emitting diode (OLED).

Various embodiments provide a method for producing a light-emitting component. The method may include forming an electrically active region, wherein forming the electrically active region may include forming a first electrode; forming a second electrode; and forming an organic functional layer structure between the first electrode and the second electrode. Furthermore, the method may include forming a layer structure having at least one layer above the electrically active region; and forming a cover above the layer structure; wherein the at least one layer of the layer structure has a refractive index which is less than the refractive index of the cover.

In one configuration, after forming the electrically active region and before forming the cover, the optical transparency of the structure having the electrically active region can be measured; and the layer structure can be formed depending on the measured optical transparency, such that a desired optical target transparency of the structure having the electrically active region and of the layer structure is obtained.

The configurations of the light-emitting component correspondingly apply, insofar as is practical, to the method for producing a light-emitting component.

It should be pointed out that, in the context of this description, the respective value of the refractive index relates to in each case one of the wavelengths of interest of the light being emitted, since the refractive index is generally not independent of the wavelength. Consequently, comparative values should be used in the case of specific wavelengths, as a result of which, however, the general statements to the effect that an index is greater or less than another retain their validity.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, like reference characters generally refer to the same parts throughout the different views. The drawings are not necessarily to scale, emphasis instead generally being placed upon illustrating the principles of the disclosed embodiments. In the following description, various embodiments described with reference to the following drawings, in which:

FIG. **1** shows a cross-sectional view of a light-emitting component in accordance with various embodiments;

FIG. **2** shows a cross-sectional view of a light-emitting component in accordance with various embodiments;

FIG. **3** shows a cross-sectional view of a light-emitting component in accordance with various embodiments;

FIG. **4** shows a diagram illustrating the transmission of light by a light-emitting reference component, as a function of the wavelength of the emitted light;

FIG. **5** shows a diagram illustrating the transmission of light by light-emitting components including an intermediate layer having in each case a different refractive index, as a function of the wavelength of the emitted light;

FIG. **6** shows a diagram illustrating the transmission of light by light-emitting components including an intermediate layer having in each case a different refractive index, as a function of the wavelength of the emitted light;

FIG. **7** shows a diagram illustrating the refractive index as a function of the light wavelength for various materials; and

FIG. **8** shows a flow chart illustrating a method for producing a light-emitting component in accordance with various embodiments.

DETAILED DESCRIPTION

The following detailed description refers to the accompanying drawing that show, by way of illustration, specific details and embodiments in which the disclosure may be practiced.

In the following detailed description, reference is made to the accompanying drawings, which form part of this description and show for illustration purposes specific embodiments in which the disclosure can be implemented. In this regard, direction terminology such as, for instance, "at the top", "at the bottom", "at the front", "at the back", "front", "rear", etc. is used with respect to the orientation of the figure(s) described. Since component parts of embodiments can be positioned in a number of different orientations, the direction terminology serves for illustration and is not restrictive in any way whatsoever. It goes without saying that other embodiments can be used and structural or logical changes can be made, without departing from the scope of protection of the present disclosure. It goes without saying that the features of the various embodiments described herein can be combined with one another, unless specifically indicated otherwise. Therefore, the following detailed description should not be interpreted in a restrictive sense, and the scope of protection of the present disclosure is defined by the appended claims.

In the context of this description, the terms "connected" and "coupled" are used to describe both a direct and an indirect connection and a direct or indirect coupling. In the figures, identical or similar elements are provided with identical reference signs, insofar as this is expedient.

In various embodiments, a light-emitting component can be embodied as an organic light-emitting diode (OLED), or as an organic light-emitting transistor. In various embodiments, the light-emitting component can be part of an integrated circuit. Furthermore, a plurality of light-emitting components can be provided, for example in a manner accommodated in a common housing.

FIG. **1** shows a cross-sectional view of a light-emitting component **100** in accordance with various embodiments.

The light-emitting component **100** in the form of an organic light-emitting diode **100** may have a substrate **102**. The substrate **102** may serve for example as a carrier element for electronic elements or layers, for example light-emitting elements. By way of example, the substrate **102** may include or be formed from glass, quartz, and/or a semiconductor material or any other suitable material. Furthermore, the substrate **102** may include or be formed from a plastic film or a laminate including one or including a plurality of plastic films. The plastic may include or be formed from one or more polyolefins (for example high or low density polyethylene (PE) or polypropylene (PP)). Furthermore, the plastic may include or be formed from polyvinyl chloride (PVC), polystyrene (PS), polyester and/or polycarbonate (PC), polyethylene terephthalate (PET), polyether sulfone (PES) and/or polyethylene naphthalate (PEN). The substrate **102** may include one or more of the materials mentioned above. The substrate **102** can be embodied as translucent or even transparent.

In various embodiments, the term "translucent" or "translucent layer" can be understood to mean that a layer is transmissive to light, for example to the light generated by the light-emitting component, for example in one or more wavelength ranges, for example to light in a wavelength range of visible light (for example at least in a partial range of the wavelength range of from 380 nm to 780 nm). By way of example, in various embodiments, the term "translucent layer" should be understood to mean that substantially the entire quantity of light coupled into a structure (for example a layer) is also coupled out from the structure (for example layer), wherein part of the light can be scattered in this case.

In various embodiments, the term "transparent" or "transparent layer" can be understood to mean that a layer is transmissive to light (for example at least in a partial range of the wavelength range of from 380 nm to 780 nm), wherein light coupled into a structure (for example a layer) is also coupled out from the structure (for example layer) substantially without scattering or light conversion. Consequently, in various embodiments, "transparent" should be regarded as a special case of "translucent".

For the case where, for example, a light-emitting monochromatic or emission spectrum-limited electronic component is intended to be provided, it suffices for the optically translucent layer structure to be translucent at least in a partial range of the wavelength range of the desired monochromatic light or for the limited emission spectrum.

In various embodiments, the organic light-emitting diode **100** (or else the light-emitting components in accordance with the embodiments that have been described above or will be described below) can be designed as a so-called top and bottom emitter. A top and bottom emitter may also be designated as an optically transparent component, for example a transparent organic light-emitting diode.

In various embodiments, a barrier layer **104** may optionally be arranged on or above the substrate **102**. The barrier layer **104** may include or consist of one or more of the following materials: aluminum oxide, zinc oxide, zirconium oxide, titanium oxide, hafnium oxide, tantalum oxide lanthanium oxide, silicon oxide, silicon nitride, silicon oxynitride, indium tin oxide, indium zinc oxide, aluminum-doped zinc oxide, and mixtures and alloys thereof. Furthermore, in various embodiments, the barrier layer **104** may have a layer thickness in a range of approximately 0.1 nm (one atomic layer) to approximately 5000 nm, for example a layer thickness in a range of approximately 10 nm to approximately 200 nm, for example a layer thickness of approximately 40 nm.

An electrically active region **106** of the light-emitting component **100** can be arranged on or above the barrier layer **104**. The electrically active region **106** can be understood as that region of the light-emitting component **100** in which an electric current for the operation of the light-emitting component **100** flows. In various embodiments, the electrically active region **106** can have a first electrode **108**, a second electrode **112** and an organic functional layer structure **110**, as will be explained in even greater detail below.

In this regard, in various embodiments, the first electrode **108** (for example in the form of a first electrode layer **108**) may be applied on or above the barrier layer **104** (or, if the barrier layer **104** is not present, on or above the substrate **102**). The first electrode **108** (also designated hereinafter as bottom electrode **108**) may be formed from an electrically conductive material, such as, for example, a metal or a transparent conductive oxide (TCO) or a layer stack including a plurality of layers of the same metal or different metals and/or the same TCO or different TCOs. Transparent conductive oxides are transparent conductive materials, for example metal oxides, such as, for example, zinc oxide, tin oxide, cadmium oxide, titanium oxide, indium oxide, or indium tin oxide (ITO). Alongside binary metal-oxygen compounds, such as, for example, ZnO, SnO_2, or In_2O_3, ternary metal-oxygen compounds, such as, for example, AlZnO, Zn_2SnO_4, $CdSnO_3$, $ZnSnO_3$, $MgIn_2O_4$, $GaInO_3$, $Zn_2In_2O_5$ or $In_4Sn_3O_{12}$, or mixtures of different transparent conductive oxides also belong to the group of TCOs and can be used in various embodiments. Furthermore, the TCOs do not necessarily correspond to a stoichiometric composition and can furthermore be p-doped or n-doped.

In various embodiments, the first electrode **108** may include a metal; for example Ag, Pt, Au, Mg, Al, Ba, In, Ag, Au, Mg, Ca, Sm or Li, and compounds, combinations or alloys of these materials.

In various embodiments, the first electrode **108** may be formed by a layer stack of a combination of a layer of a metal on a layer of a TCO, or vice versa. One example is a silver layer applied on an indium tin oxide layer (ITO) (Ag on ITO) or ITO-Ag-ITO multilayers.

In various embodiments, the first electrode **108** may provide one or a plurality of the following materials as an alternative or in addition to the abovementioned materials: networks composed of metallic nanowires and nanoparticles, for example composed of Ag; networks composed of carbon nanotubes; graphene particles and graphene layers; networks composed of semiconducting nanowires.

Furthermore, the first electrode **108** may include electrically conductive polymers or transition metal oxides or transparent electrically conductive oxides.

In various embodiments, the first electrode **108** and the substrate **102** may be formed as translucent or transparent. In the case where the first electrode **108** is formed from a metal, the first electrode **108** may have for example a layer thickness of less than or equal to approximately 25 nm, for example a layer thickness of less than or equal to approximately 20 nm, for example a layer thickness of less than or equal to approximately 18 nm. Furthermore, the first electrode **108** may have for example a layer thickness of greater than or equal to approximately 10 nm, for example a layer thickness of greater than or equal to approximately 15 nm. In various embodiments, the first electrode **108** may have a layer thickness in a range of approximately 10 nm to approximately 25 nm, for example a layer thickness in a range of approximately 10 nm to approximately 18 nm, for example a layer thickness in a range of approximately 15 nm to approximately 18 nm.

Furthermore, for the case where the first electrode **108** is formed from a transparent conductive oxide (TCO), the first electrode **108** may have for example a layer thickness in a range of approximately 50 nm to approximately 500 nm, for example a layer thickness in a range of approximately 75 nm to approximately 250 nm, for example a layer thickness in a range of approximately 100 nm to approximately 150 nm.

Furthermore, for the case where the first electrode **108** is formed from, for example, a network composed of metallic nanowires, for example composed of Ag, which may be combined with conductive polymers, a network composed of carbon nanotubes which can be combined with conductive polymers, or from graphene layers and composites, the first electrode **108** can have for example a layer thickness in a range of approximately 1 nm to approximately 500 nm, for example a layer thickness in a range of approximately 10 nm to approximately 400 nm, for example a layer thickness in a range of approximately 40 nm to approximately 250 nm.

The first electrode **108** may be formed as an anode, that is to say as a hole-injecting electrode, or as a cathode, that is to say as an electron-injecting electrode.

The first electrode **108** can have a first electrical terminal, to which a first electrical potential (provided by an energy store (not illustrated), for example a current source or a voltage source) can be applied. Alternatively, the first electrical potential can be applied to the substrate **102** and then be fed indirectly to the first electrode **108** via said substrate. The first electrical potential can be, for example, the ground potential or some other predefined reference potential.

Furthermore, the electrically active region **106** of the light-emitting component **100** may have an organic electroluminescent layer structure **110**, which is applied on or above the first electrode **108**.

The organic electroluminescent layer structure **110** may contain one or a plurality of emitter layers **114**, for example including fluorescent and/or phosphorescent emitters, and one or a plurality of hole-conducting layers **116** (also designated as hole transport layer(s) **116**). In various embodiments, one or a plurality of electron-conducting layers **118** (also designated as electron transport layer(s) **118**) can alternatively or additionally be provided.

Examples of emitter materials which can be used in the light-emitting component **100** in accordance with various embodiments for the emitter layer(s) **114** include organic or organometallic compounds such as derivatives of polyfluorene, polythiophene and polyphenylene (e.g. 2- or 2,5-substituted poly-p-phenylene vinylene) and metal complexes, for example iridium complexes such as blue phosphorescent FIrPic (bis(3,5-difluoro-2-(2-pyridyl)phenyl-(2-carboxypyridyl)-iridium III), green phosphorescent $Ir(ppy)_3$ (tris(2-phenylpyridine)iridium III), red phosphorescent Ru $(dtb\text{-}bpy)_3{*}2(PF_6)$ (tris[4,4'-di-tert-butyl-(2,2')-bipyridine]ruthenium(III) complex) and blue fluorescent DPAVBi (4,4-bis[4-(di-p-tolylamino)styryl]biphenyl), green fluorescent TTPA (9,10-bis[N,N-di-(p-tolyl)-amino]anthracene) and red fluorescent DCM2 (4-dicyanomethylene)-2-methyl-6-julolidyl-9-enyl-4H-pyran) as non-polymeric emitters. Such non-polymeric emitters can be deposited by means of thermal evaporation, for example. Furthermore, it is possible to use polymer emitters, which can be deposited, in particular, by means of a wet-chemical method such as spin coating, for example.

The emitter materials can be embedded in a matrix material in a suitable manner.

It should be pointed out that other suitable emitter materials are likewise provided in other embodiments.

The emitter materials of the emitter layer(s) **114** of the light-emitting component **100** can be selected for example such that the light-emitting component **100** emits white light. The emitter layer(s) **114** may include a plurality of emitter materials that emit in different colors (for example blue and yellow or blue, green and red); alternatively, the emitter layer(s) **114** can also be constructed from a plurality of partial layers, such as a blue fluorescent emitter layer **114** or blue phosphorescent emitter layer **114**, a green phosphorescent emitter layer **114** and a red phosphorescent emitter layer **114**. By mixing the different colors, the emission of light having a white color impression can result. Alternatively, provision can also be made for arranging a converter material in the beam path of the primary emission generated by said layers, which converter material at least partly absorbs the primary radiation and emits a secondary radiation having a different wavelength, such that a white color impression results from a (not yet white) primary radiation by virtue of the combination of primary and secondary radiation.

The organic electroluminescent layer structure **110** may generally include one or a plurality of electroluminescent layers. The one or the plurality of electroluminescent layers may include organic polymers, organic oligomers, organic monomers, organic small, non-polymeric molecules (“small molecules”) or a combination of these materials. By way of example, the organic electroluminescent layer structure **110** may include one or a plurality of electroluminescent layers embodied as a hole transport layer **116**, so as to enable for example in the case of an OLED an effective hole injection into an electroluminescent layer or an electroluminescent region. Alternatively, in various embodiments, the organic electroluminescent layer structure **110** may include one or a plurality of functional layers embodied as an electron transport layer **118**, so as to enable for example in an OLED an effective electron injection into an electroluminescent layer or an electroluminescent region. By way of example, tertiary amines, carbazo derivatives, conductive polyaniline or polyethylene dioxythiophene can be used as material for the hole transport layer **116**. In various embodiments, the one or the plurality of electroluminescent layers can be embodied as an electroluminescent layer.

In various embodiments, the hole transport layer **116** may be applied, for example deposited, on or above the first electrode **108**, and the emitter layer **114** can be applied, for example deposited, on or above the hole transport layer **116**. In various embodiments, the electron transport layer **118** can be applied, for example deposited, on or above the emitter layer **114**.

In various embodiments, the organic electroluminescent layer structure **110** (that is to say for example the sum of the thicknesses of hole transport layer(s) **116** and emitter layer(s) **114** and electron transport layer(s) **118**) may have a layer thickness of a maximum of approximately 1.5 μm, for example a layer thickness of a maximum of approximately 1.2 μm, for example a layer thickness of a maximum of approximately 1 μm, for example a layer thickness of a maximum of approximately 800 nm, for example a layer thickness of a maximum of approximately 500 nm, for example a layer thickness of a maximum of approximately 400 nm, for example a layer thickness of a maximum of approximately 300 nm. In various embodiments, the organic electroluminescent layer structure **110** can have for example a stack of a plurality of organic light-emitting diodes (OLEDs) arranged directly one above another, wherein each OLED can have for example a layer thickness of a maximum of approximately 1.5 μm, for example a layer thickness of a maximum of approximately 1.2 μm, for example a layer thickness of a maximum of approximately 1 μm, for example a layer thickness of a maximum of approximately 800 nm, for example a layer thickness of a maximum of approximately 500 nm, for example a layer thickness of a maximum of approximately 400 nm, for example a layer thickness of a maximum of approximately 300 nm. In various embodiments, the organic electroluminescent layer structure **110** can have for example a stack of two, three or four OLEDs arranged directly one above another, in which case for example the organic electroluminescent layer structure **110** can have a layer thickness of a maximum of approximately 3 μm.

The light-emitting component **100** may optionally generally include further organic functional layers, for example arranged on or above the one or the plurality of emitter layers **114** or on or above the electron transport layer(s) **118**, which serve to further improve the functionality and thus the efficiency of the light-emitting component **100**.

The second electrode **112** (for example in the form of a second electrode layer **112**) can be applied on or above the organic electroluminescent layer structure **110** or, if appropriate, on or above the one or the plurality of further organic functional layers.

In various embodiments, the second electrode **112** may include or be formed from the same materials as the first electrode **108**, metals being particularly suitable in various embodiments.

In various embodiments, the second electrode **112** (for example for the case of a metallic second electrode **112**) can have for example a layer thickness of less than or equal to approximately 50 nm, for example a layer thickness of less than or equal to approximately 45 nm, for example a layer thickness of less than or equal to approximately 40 nm, for example a layer thickness of less than or equal to approximately 35 nm, for example a layer thickness of less than or equal to approximately 30 nm, for example a layer thickness of less than or equal to approximately 25 nm, for example a layer thickness of less than or equal to approximately 20 nm, for example a layer thickness of less than or equal to approximately 15 nm, for example a layer thickness of less than or equal to approximately 10 nm.

The second electrode **112** can generally be formed in a similar manner to the first electrode **108**, or differently than the latter. In various embodiments, the second electrode **112** can be formed from one or more of the materials and with the respective layer thickness, as described above in connection with the first electrode **108**. In various embodiments, both the first electrode **108** and the second electrode **112** are formed as translucent or transparent. Consequently, the light-emitting component **100** illustrated in FIG. **1** can be designed as a top and bottom emitter (to put it another way as a transparent light-emitting component **100**).

The second electrode **112** may be formed as an anode, that is to say as a hole-injecting electrode, or as a cathode, that is to say as an electron-injecting electrode.

The second electrode **112** may have a second electrical terminal, to which a second electrical potential (which is different than the first electrical potential), provided by the energy source, can be applied. The second electrical potential can have for example a value such that the difference with respect to the first electrical potential has a value in a range of approximately 1.5 V to approximately 20 V, for example a value in a range of approximately 2.5 V to approximately 15 V, for example a value in a range of approximately 3 V to approximately 12 V.

An encapsulation **120**, for example in the form of a barrier thin-film layer/thin-film encapsulation **120**, can optionally also be formed on or above the second electrode **112** and thus on or above the electrically active region **106**.

In the context of this application, a "barrier thin-film layer" or a "barrier thin film" **120** may be understood to mean, for example, a layer or a layer structure which is suitable for forming a barrier against chemical impurities or atmospheric substances, in particular against water (moisture) and oxygen. In other words, the barrier thin-film layer **120** is formed in such a way that OLED-damaging substances such as water, oxygen or solvent cannot penetrate through it or at most very small proportions of said substances can penetrate through it.

In accordance with one configuration, the barrier thin-film layer **120** can be formed as an individual layer (to put it another way, as a single layer). In accordance with an alternative configuration, the barrier thin-film layer **120** may include a plurality of partial layers formed one on top of another. In other words, in accordance with one configuration, the barrier thin-film layer **120** can be formed as a layer stack. The barrier thin-film layer **120** or one or a plurality of partial layers of the barrier thin-film layer **120** can be formed for example by means of a suitable deposition method, e.g. by means of an atomic layer deposition (ALD) method in accordance with one configuration, e.g. a plasma enhanced atomic layer deposition (PEALD) method or a plasmaless atomic layer deposition (PLALD) method, or by means of a chemical vapor deposition (CVD) method in accordance with another configuration, e.g. a plasma enhanced chemical vapor deposition (PECVD) method or a plasmaless chemical vapor deposition (PECVD) method, or alternatively by means of other suitable deposition methods.

By using an atomic layer deposition (ALD) method, it is possible for very thin layers to be deposited. In particular, layers having layer thicknesses in the atomic layer range can be deposited.

In accordance with one configuration, in the case of a barrier thin-film layer **120** having a plurality of partial layers, all the partial layers can be formed by means of an atomic layer deposition method. A layer sequence including only ALD layers can also be designated as a "nanolaminate".

In accordance with an alternative configuration, in the case of a barrier thin-film layer **120** including a plurality of partial layers, one or a plurality of partial layers of the barrier thin-film layer **120** can be deposited by means of a different deposition method than an atomic layer deposition method, for example by means of a vapor deposition method.

In accordance with one configuration, the barrier thin-film layer **120** may have a layer thickness of approximately 0.1 nm (one atomic layer) to approximately 1000 nm, for example a layer thickness of approximately 10 nm to approximately 100 nm in accordance with one configuration, for example approximately 40 nm in accordance with one configuration.

In accordance with one configuration in which the barrier thin-film layer **120** includes a plurality of partial layers, all the partial layers can have the same layer thickness. In accordance with another configuration, the individual partial layers of the barrier thin-film layer **120** can have different layer thicknesses. In other words, at least one of the partial layers can have a different layer thickness than one or more other partial layers.

In accordance with one configuration, the barrier thin-film layer **120** or the individual partial layers of the barrier thin-film layer **120** may be formed as a translucent or transparent layer. In other words, the barrier thin-film layer **120** (or the individual partial layers of the barrier thin-film layer **120**) may consist of a translucent or transparent material (or a material combination that is translucent or transparent).

In accordance with one configuration, the barrier thin-film layer **120** or (in the case of a layer stack having a plurality of partial layers) one or a plurality of the partial layers of the barrier thin-film layer **120** may include or consist of one of the following materials: aluminum oxide, zinc oxide, zirconium oxide, titanium oxide, hafnium oxide, tantalum oxide lanthanium oxide, silicon oxide, silicon nitride, silicon oxynitride, indium tin oxide, indium zinc oxide, aluminum-doped zinc oxide, and mixtures and alloys thereof. In various embodiments, the barrier thin-film layer **120** or (in the case of a layer stack having a plurality of partial layers) one or a plurality of the partial layers of the barrier thin-film layer **120** may include one or a plurality of high refractive index materials, to put it another way one or a plurality of materials having a high refractive index, for example having a refractive index of at least 2.

In various embodiments, a low refractive index intermediate layer or low refractive index intermediate layer structure **122** (for example having one or a plurality of layers composed of the same material or different materials) may be arranged on or above the encapsulation **120** and serves, in the case of a transparent light-emitting component **100**, to increase the total transparency thereof.

The intermediate layer **122** or intermediate layer structure **122** may include at least one layer which (at a predefined wavelength (for example at a predefined wavelength in a wavelength range of 380 nm to 780 nm)) has a refractive index which is less than the refractive index of a cover (at the predefined wavelength) of the light-emitting component **100**, as will be explained in even greater detail below. In various embodiments, the intermediate layer or the at least one layer of the intermediate layer structure **122** or the entire intermediate layer structure **122** can have a refractive index which is less than the refractive index of a cover of the light-emitting component **100** as will be explained in even greater detail below. In various embodiments, the intermediate layer or the at least one layer of the intermediate layer structure **122** or the entire intermediate layer structure **122** can have a refractive index of less than 1.5, for example a refractive index of less than 1.49, for example a refractive index of less than 1.48, for example a refractive index of less than 1.47, for example a refractive index of less than 1.46, for example a refractive index of less than 1.45, for example a refractive index of less than 1.44, for example a refractive index of less than 1.43, for example a refractive index of less than 1.42, for example a refractive index of less than 1.41, for example a refractive index of less than 1.40, for example a refractive index of less than 1.39, for example a refractive index of less than 1.38, for example a refractive index of less than 1.37, for example a refractive index of less than 1.36, for example a refractive index of less than 1.35, for example a refractive index of less than 1.34, for example a refractive index of less than 1.33, for example a refractive index of less than 1.32, for example a refractive index of less than 1.31, for example a refractive index of less than 1.30, for example a refractive index of less than 1.25, for example a refractive index of less than 1.20, for example a refractive index of less than 1.15.

In various embodiments, the intermediate layer or the at least one layer of the intermediate layer structure **122** or the entire intermediate layer structure **122** may include at least one fluoride or one fluorine-containing polymer. A fluoride is particularly suitable since it usually has a relatively low refractive index. In this regard, by way of example, one or more of the following fluorides can be used in various embodiments:

- potassium fluoride (KF) (refractive index of approximately 1.36 at a light wavelength of 633 nm);
- lithium fluoride (LiF) (refractive index of approximately 1.39 at a light wavelength of 633 nm);
- magnesium fluoride (MgF_2) (refractive index of approximately 1.38 at a light wavelength of 633 nm);
- sodium fluoride (NaF) (refractive index of approximately 1.32 at a light wavelength of 633 nm);
- sodium aluminum fluoride (Na_3AlF_6) (refractive index of approximately 1.35 at a light wavelength of 633 nm);
- barium fluoride (BaF_2) (refractive index of approximately 1.47 at a light wavelength of 633 nm);
- calcium fluoride (CaF_2) (refractive index of approximately 1.43 at a light wavelength of 633 nm);
- lithium calcium aluminum fluoride ($LiCaAlF_6$) (refractive index of approximately 1.39 at a light wavelength of 633 nm);
- lithium yttrium fluoride ($LiYF_4$) (refractive index of approximately 1.45 at a light wavelength of 633 nm);
- strontium fluoride (SrF_2) (refractive index of approximately 1.44 at a light wavelength of 633 nm).

As fluorine-containing polymer, in various embodiments, by way of example, it is possible to provide the material class of the group of amorphous fluoropolymers for example based on the copolymers of 2,2-bistrifluoromethyl-4,5-difluoro-1,3-dioxole (PDD). One example thereof is the material Teflon AF from Dupont (polytetrafluoroethylene, named as: fluorinated ethylenic cyclo oxyaliphatic substituted ethylenic copolymer). Teflon AF is commercially available and can be spin-coated, for example, in various solvents in the context of various embodiments. One advantage of this material class can be seen in the high (mechanical) durability.

In various embodiments, the intermediate layer or the at least one layer of the intermediate layer structure **122** or the entire intermediate layer structure **122** may include a matrix having air inclusions (for example having a pore size of less than approximately 40 nm (for example of approximately 1 nm to approximately 40 nm), for example having a pore size of less than approximately 30 nm (for example of approximately 1 nm to approximately 30 nm), for example having a pore size of less than approximately 20 nm (for example of approximately 1 nm to approximately 20 nm), for example having a pore size of less than approximately 10 nm (for example of approximately 1 nm to approximately 10 nm).

In various embodiments, the intermediate layer or the at least one layer of the intermediate layer structure **122** or the entire intermediate layer structure **122** may include a matrix having particles which reduce the refractive index of the matrix. By way of example, the particles may include or be formed from one or a plurality of the following materials: small air inclusions (also designated as pores); aerogel; and SiO. In various embodiments, the structure size of the air inclusions is in this case less than 50 nm.

In various embodiments, the intermediate layer or the at least one layer of the intermediate layer structure **122** or the entire intermediate layer structure **122** may include aerogel or water encapsulated in the layer structure or in the light-emitting component.

All the stated materials of the low refractive index intermediate layer or intermediate layer structure have a refractive index at the wavelengths of interest of the light emitted by the light-emitting component **100** which is less than the refractive index of the cover (and if appropriate, if present, of the adhesive (also designated as lamination adhesive)) at the respective wavelength(s) of the light emitted by the light-emitting component **100**.

In various embodiments, the intermediate layer **122** or the at least one layer of the intermediate layer structure **122** or the entire intermediate layer structure **122** can have a layer thickness in a range of approximately 50 nm to approximately 150 nm, for example a layer thickness in a range of approximately 70 nm to approximately 130 nm, for example a layer thickness in a range of approximately 90 nm to approximately 110 nm. The effect of an increase in transparency is particularly high in these layer thickness ranges.

Alternatively, it was established that the effect of an increase in transparency is likewise particularly high in the case of a layer thickness in a range of approximately 5 μm to approximately 50 μm, for example in the case of a layer thickness in a range of approximately 10 μm to approximately 40 μm, for example in the case of a layer thickness in a range of approximately 20 μm to approximately 30 μm.

In various embodiments, the intermediate layer structure **122** may include a layer sequence having a plurality of low refractive index layers having different refractive indices.

On or above the intermediate layer **122** or the intermediate layer structure **122**, it is possible to provide an adhesive and/or a protective lacquer **124**, by means of which, for example, a cover **126** (for example a glass cover **126**, is fixed, for example adhesively bonded, on the intermediate layer **122** or the intermediate layer structure **122**. In various embodiments, the optically translucent layer composed of adhesive and/or protective lacquer **124** can have a layer thickness of greater than 1 μm, for example a layer thickness of several μm. In various embodiments, the adhesive may include or be a lamination adhesive.

In various embodiments, light-scattering particles can also be embedded into the layer of the adhesive (also designated as adhesive layer), which particles can lead to a further improvement in the color angle distortion and the coupling-out efficiency. In various embodiments, the light-scattering particles provided can be dielectric scattering particles, for example, such as metal oxides, for example, such as e.g. silicon oxide (SiO_2), zinc oxide (ZnO), zirconium oxide (ZrO_2), indium tin oxide (ITO) or indium zinc oxide (IZO), gallium oxide (Ga_2Oa), aluminum oxide, or titanium oxide. Other particles may also be suitable provided that they have a refractive index that is different than the effective refractive index of the matrix of the translucent layer structure, for example air bubbles, acrylate, or hollow glass beads. Furthermore, by way of example, metallic nanoparticles, metals such as gold, silver, iron nanoparticles, or the like can be provided as light-scattering particles.

In various embodiments, between the second electrode **112** and the layer composed of adhesive and/or protective lacquer **124** an electrically insulating layer (not shown) can also be applied, for example SiN, for example having a layer thickness in a range of approximately 300 nm to approximately 1.5 μm, for example having a layer thickness in a range of approximately 500 nm to approximately 1 μm, in order to protect electrically unstable materials, during a wet-chemical process for example.

In various embodiments, the adhesive can be designed in such a way that it itself has a refractive index which is less than the refractive index of the cover **126**. In this case, the adhesive itself illustratively forms the intermediate layer **122** or the intermediate layer structure **122** or a part thereof. Such an adhesive can be, for example, a low refractive index adhesive such as, for example, an acrylate having a refractive index of approximately 1.3. Furthermore, a plurality of different adhesives which form an adhesive layer sequence can be provided.

Furthermore, it should be pointed out that, in various embodiments, an adhesive **124** may also be completely dispensed with, for example in embodiments in which the cover **126**, for example composed of glass, is applied to the intermediate layer **122** or the intermediate layer structure **122** by means of plasma spraying, for example.

In embodiments in which both an intermediate layer **122** or an intermediate layer structure **122** and an adhesive **124** are provided, the at least one layer of the layer structure may have a refractive index which is also less than the refractive index of the adhesive **124**.

In various embodiments, the cover **126** and/or the adhesive **124** may have a refractive index (for example at a wavelength of 633 nm) of 1.55.

Furthermore, in various embodiments, one or a plurality of antireflective layers (for example combined with the encapsulation **120**, for example the thin-film encapsulation **120**) may additionally be provided in the light-emitting component **100**.

FIG. **2** shows a cross-sectional view of a light-emitting component **200** in accordance with various embodiments, for example likewise implemented as an organic light-emitting diode **200**.

The organic light-emitting diode **200** in accordance with FIG. **2** is identical in many aspects to the organic light-emitting diode **100** in accordance with FIG. **1**, for which reason only the differences between the organic light-emitting diode **200** in accordance with FIG. **2** and the organic light-emitting diode **100** in accordance with FIG. **1** are explained in greater detail below; with regard to the remaining elements of the organic light-emitting diode **200** in accordance with FIG. **2**, reference is made to the above explanations concerning the organic light-emitting diode **100** in accordance with FIG. **1**.

In contrast to the organic light-emitting diode **100** in accordance with FIG. **1**, in the case of the organic light-emitting diode **200** in accordance with FIG. **2**, an additional cover **202**, for example likewise composed of glass **204**, is also provided below the substrate **102** and, analogously to the cover **126**, can optionally be fixed by means of an adhesive **204**, for example can be adhesively bonded.

In various embodiments, the light-emitting component **200** may be designed as a top and bottom emitter.

In various embodiments, a second intermediate layer **206** or intermediate layer structure **206** may be arranged between the exposed underside of the substrate **102** and the additional cover **202** and if appropriate, if present, the adhesive **204**.

The second intermediate layer **206** or intermediate layer structure **206** may be constructed in the same way as the intermediate layer **122** or intermediate layer structure **122** such as was explained in connection with the light-emitting component **100** in FIG. **1**. The adhesive **204**, too, may be constructed in the same way as the adhesive **124** such as was explained in connection with the light-emitting component **100** in FIG. **1**.

The intermediate layer **122** or intermediate layer structure **122** from FIG. **1** is omitted in the embodiments illustrated in FIG. **2**.

FIG. **3** shows a cross-sectional view of a light-emitting component **300** in accordance with various embodiments, for example likewise implemented as an organic light-emitting diode **300**.

Illustratively, the organic light-emitting diode **300** in accordance with FIG. **3** is a combination of the organic light-emitting diode **100** in accordance with FIG. **1** and the organic light-emitting diode **200** in accordance with FIG. **2**.

In various embodiments, the organic light-emitting diode **300** in accordance with FIG. **3** is designed as a transparent organic light-emitting diode **300**.

Illustratively, in various embodiments, at least one low refractive index intermediate layer or intermediate layer structure is arranged outside the electrically active region **106**, but between the electrically active region **106** and the cover **126** and/or the second cover **202**.

In various embodiments which can be combined arbitrarily with the embodiments described above, a low refractive index intermediate layer or intermediate layer structure can also be provided (not illustrated) between the substrate **102** and the first electrode **108** (if the barrier layer **104** is not present). For the case where the barrier layer **104** is provided, a low refractive index intermediate layer or intermediate layer structure can also be provided between the substrate **102** and the barrier layer **104** or between the barrier layer **104** and the first electrode **108** (not illustrated). Furthermore, an intermediate layer or intermediate layer structure can also be provided (not illustrated) within the encapsulation, i.e. for example within inorganic encapsulation layers (for example the topmost silicon oxide layer of the encapsulation).

FIG. **4** shows a diagram **400** illustrating the transmission of light by a light-emitting reference component, as a function of the wavelength of the emitted light. In terms of construction, the light-emitting reference component corresponds to the light-emitting component **100** as illustrated in FIG. **1**, but without the intermediate layer **122** or intermediate layer structure **122**. What is found on the basis of the simulation carried out is the characteristic curve **402** illustrated in FIG. **4** with an average transmission value (also designated as transparency value) T=46.5%.

FIG. **5** shows a diagram **500** illustrating the transmission of light by light-emitting component including an intermediate layer having in each case a different refractive index, as a function of the wavelength of the emitted light.

In specific detail, the diagram **500** illustrates:

- a first characteristic curve **502**, which represents the transmission for a light-emitting component including an intermediate layer **122** having a refractive index of 1.5 and a layer thickness of 85 nm (this results in an average transmission value T=48.44% for a wavelength range of 450 nm to 650 nm);
- a second characteristic curve **504**, which represents the transmission for a light-emitting component including an intermediate layer **122** having a refractive index of 1.4 (for example composed of MgF_2) and a layer thickness of 90 nm (this results in an average transmission value T=51.44% for a wavelength range of 450 nm to 650 nm);
- a third characteristic curve **506**, which represents the transmission for a light-emitting component including an intermediate layer **122** having a refractive index of 1.3 (for example composed of Teflon AF from Dupont) and a layer thickness of 100 nm (this results in an average transmission value T=54.44% for a wavelength range of 450 nm to 650 nm);
- a fourth characteristic curve **508**, which represents the transmission for a light-emitting component including an intermediate layer **122** having a refractive index of 1.2 and a layer thickness of 110 nm (this results in an average transmission value T=57.27% for a wavelength range of 450 nm to 650 nm);
- a fifth characteristic curve **510**, which represents the transmission for a light-emitting component including an

intermediate layer **122** having a refractive index of 1.1 and a layer thickness of 125 nm (this results in an average transmission value T=59.75% for a wavelength range of 450 nm to 650 nm); and

a sixth characteristic curve **512**, which represents the transmission for a light-emitting component including an intermediate layer **122** having a refractive index of 1.0 and a layer thickness of 140 nm (this results in an average transmission value T=61.6% for a wavelength range of 450 nm to 650 nm).

It is evident that the transmission and thus the transparency of the light-emitting component **100** is increased, the lower the refractive index of the intermediate layer **122** or intermediate layer structure **122**.

The following table shows for some selected materials for the intermediate layer **122** once again the refractive index of the material at a light wavelength of 633 nm and an "optimum layer thickness" of the intermediate layer **122**. In this case, the expression "optimum layer thickness" relates to the optimum layer thickness relative to the reference component for the purpose of obtaining the highest possible transparency in the wavelength range of 450 nm to 650 nm.

Material	Refractive index at 633 nm	Optimum layer thickness [nm]
BaF_2	1.473	88.25
CaF_2	1.43289	91.51
KF	1.3616	97.29
$LiCaAlF_6$	1.39151	94.83
LiF	1.39127	94.84
LiY_4	1.4469	90.32
MgF_2	1.37698	96.02
NaF	1.32454	100.43
SrF_2	1.4369	91.20
Teflon AF	Approximately 1.3	Approximately 100

FIG. **6** shows a diagram **600** illustrating the transmission of light by light-emitting component including an intermediate layer having the materials presented in the table above, as a function of the wavelength of the emitted light.

In specific detail, the diagram **600** illustrates:

a first characteristic curve **602**, which represents the transmission for a light-emitting component including an intermediate layer **122** composed of BaF_2 having a layer thickness of 88.25 nm (this results in an average transmission value T=49.2% for a wavelength range of 450 nm to 650 nm);

a second characteristic curve **604**, which represents the transmission for a light-emitting component including an intermediate layer **122** composed of CaF_2 having a layer thickness of 91.51 nm (this results in an average transmission value T=50.4% for a wavelength range of 450 nm to 650 nm);

a third characteristic curve **606**, which represents the transmission for a light-emitting component including an intermediate layer **122** composed of KF having a layer thickness of 97.29 nm (this results in an average transmission value T=52.6% for a wavelength range of 450 nm to 650 nm);

a fourth characteristic curve **608**, which represents the transmission for a light-emitting component including an intermediate layer **122** composed of $LiCaAlF_6$ having a layer thickness of 94.83 nm (this results in an average transmission value T=51.7% for a wavelength range of 450 nm to 650 nm);

a fifth characteristic curve **610**, which represents the transmission for a light-emitting component including an intermediate layer **122** composed of LiF having a layer thickness of 94.84 nm (this results in an average transmission value T=51.7% for a wavelength range of 450 nm to 650 nm);

a sixth characteristic curve **612**, which represents the transmission for a light-emitting component including an intermediate layer **122** composed of $LiYF_4$ having a layer thickness of 90.32 nm (this results in an average transmission value T=50.0% for a wavelength range of 450 nm to 650 nm);

a seventh characteristic curve **614**, which represents the transmission for a light-emitting component including an intermediate layer **122** composed of MgF_2 having a layer thickness of 96.02 nm (this results in an average transmission value T=52.1% for a wavelength range of 450 nm to 650 nm);

an eighth characteristic curve **616**, which represents the transmission for a light-emitting component including an intermediate layer **122** composed of NaF having a layer thickness of 100.43 nm (this results in an average transmission value T=53.7% for a wavelength range of 450 nm to 650 nm); and

a ninth characteristic curve **618**, which represents the transmission for a light-emitting component including an intermediate layer **122** composed of SrF_2 having a layer thickness of 91.20 nm (this results in an average transmission value T=50.3% for a wavelength range of 450 nm to 650 nm).

FIG. **7** shows a diagram **700** illustrating the refractive index as a function of the light wavelength (in a wavelength range of 350 nm to 800 nm) for the materials presented in the table above.

In specific detail, the diagram **700** illustrates:

a first refractive index characteristic curve **702** for BaF_2;

a second refractive index characteristic curve **704** for $LiYF_4$;

a third refractive index characteristic curve **706** for SrF_2;

a fourth refractive index characteristic curve **708** for CaF_2;

a fifth refractive index characteristic curve **710** for $LiCaAlF_6$;

a sixth refractive index characteristic curve **712** for LiF;

a seventh refractive index characteristic curve **714** for MgF_2;

an eighth refractive index characteristic curve **716** for KF; and

a ninth refractive index characteristic curve **718** for NaF.

FIG. **8** shows a flow chart **800** illustrating a method for producing a light-emitting component in accordance with various embodiments.

In **802** an electrically active region is formed, wherein a first electrode and a second electrode are formed, and wherein an organic functional layer structure is formed between the first electrode and the second electrode. Furthermore, in **804** a layer structure having at least one layer can be formed above the electrically active region followed by forming a cover above the layer structure in **806**, wherein the at least one layer of the layer structure has a refractive index which is less than the refractive index of the cover.

The various layers, for example the intermediate layer **122** or intermediate layer structure **122**, the electrodes **108**, **112** and the other layers of the electrically active region **106** such as, for example, the organic functional layer structure **114**, the hole transport layer(s) **116** or the electron transport layer(s) **118** can be applied, for example deposited, by means of various processes, for example by means of a CVD method (chemical vapor deposition) or by means of a PVD method (physical vapor deposition, for example sputtering, ion-assisted deposition method or thermal evaporation), alternatively by means of a plating method; a dip coating method; a spin coating method; printing; blade coating; or spraying.

In various embodiments, a plasma enhanced chemical vapor deposition (PE-CVD) method can be used as CVD method. In this case, a plasma can be generated in a volume above and/or around the element to which the layer to be applied is intended to be applied, wherein at least two gaseous starting compounds are fed to the volume, said compounds being ionized in the plasma and excited to react with one another. The generation of the plasma can make it possible that the temperature to which the surface of the element is to be heated in order to make it possible to produce the dielectric layer, for example, can be reduced in comparison with a plasmaless CVD method. That may be advantageous, for example, if the element, for example the light-emitting electronic component to be formed, would be damaged at a temperature above a maximum temperature. The maximum temperature can be approximately 120° C. for example in the case of a light-emitting electronic component to be formed in accordance with various embodiments, such that the temperature at which the dielectric layer for example is applied can be less than or equal to 120° C. and for example less than or equal to 80° C.

Furthermore, it can be provided that after forming the electrically active region and before forming the cover, the optical transparency of the structure having the electrically active region is measured. The intermediate layer or intermediate layer structure can then be formed depending on the measured optical transparency, such that a desired optical target transparency of the structure having the electrically active region and of the intermediate layer or intermediate layer structure is obtained (in this regard, by way of example, the layer thickness and/or a choice of material of the intermediate layer or intermediate layer structure can be adapted).

In various embodiments it was recognized that the transparency of a light-emitting component such as an OLED, for example, can be increased by the use of a very thin layer having a low refractive index in comparison with the adhesive and cover glass (both of which usually have approximately the same refractive index). In various embodiments, the layer thickness is in a range of 50 nm to 150 nm. As explained above, the transparency of the light-emitting component can be significantly increased depending on the refractive index and the thickness of the layer.

In various embodiments, such a low refractive index layer (i.e. for example having a refractive index of less than 1.5) can be introduced in the ongoing process flow as an additional layer on the encapsulation, for example the thin-film encapsulation.

As explained above, a low refractive index intermediate layer or low refractive index intermediate layer structure increases the transparency of the light-emitting component, without significantly altering the total thickness of the light-emitting component.

It is likewise possible to use the low refractive index intermediate layer or low refractive index intermediate layer structure to compensate for changes in the transparency on account of process fluctuations of thin metal films within the light-emitting component, for example an OLED. For this purpose, after the thin-film encapsulation of the light-emitting component, the transparency can be measured and, if there is a negative deviation with respect to the target value, then said deviation can be compensated for by means of such a thin low refractive index intermediate layer or low refractive index intermediate layer structure.

While the disclosed embodiments have been particularly shown and described with reference to specific embodiments, it should be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the disclosed embodiments as defined by the appended claims. The scope of the disclosed embodiments is thus indicated by the appended claims and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced.

The invention claimed is:

1. A light-emitting component, comprising:
an electrically active region, comprising:
a first electrode;
a second electrode;
an organic functional layer structure between the first electrode and the second electrode;
a cover arranged above the electrically active region; and
a layer structure arranged between the cover and the electrically active region and having at least one layer, wherein the at least one layer has a refractive index which is less than a refractive index of the cover; and
an adhesive between the cover and the at least one layer of the layer structure for fixing the cover,
wherein the refractive index of the at least one layer of the layer structure is less than a refractive index of the adhesive,
wherein the adhesive is a different material from the at least one layer of the layer structure.

2. The light-emitting component as claimed in claim **1**, wherein the at least one layer of the layer structure has a refractive index of less than 1.5.

3. The light-emitting component as claimed in claim **1**, wherein the at least one layer of the layer structure comprises at least one fluoride or one fluorine-containing polymer.

4. The light-emitting component as claimed in claim **1**, wherein the at least one layer of the layer structure comprises a matrix having air inclusions or having particles which reduce the refractive index of the matrix.

5. The light-emitting component as claimed in claim **1**, wherein the at least one layer of the layer structure comprises aerogel or water encapsulated in the layer structure or in the light-emitting component.

6. The light-emitting component as claimed in claim **1**, wherein the layer structure has a layer thickness in a range of approximately 50 nm to approximately 150 nm; or wherein the layer structure has a layer thickness in a range of approximately 5 μm to approximately 50 μm.

7. The light-emitting component as claimed in claim **1**, further comprising a substrate and an encapsulation,
wherein the encapsulation is arranged on that side of the electrically active region which faces away from the substrate;
wherein the layer structure is arranged above the encapsulation.

8. The light-emitting component as claimed in claim **1**, wherein the cover comprises a first cover, which is arranged above a first main side of the electrically active region, and a second cover, which is arranged below a second main side of the electrically active region, said second main side being situated opposite the first main side.

9. The light-emitting component as claimed in claim **1**, designed as an organic light-emitting diode.

10. A method for producing a light-emitting component, comprising:

forming an electrically active region, wherein forming the electrically active region comprises:

forming a first electrode;

forming a second electrode;

forming an organic functional layer structure between the first electrode and the second electrode;

forming a layer structure comprising at least one layer above the electrically active region and further comprising an adhesive; and

forming a cover above the layer structure;

wherein the at least one layer of the layer structure has a refractive index which is less than a refractive index of the cover and is less than a refractive index of the adhesive, and

wherein the adhesive is between the cover and the at least one layer of the layer structure for fixing the cover.

11. The method as claimed in claim **10**,

wherein, after forming the electrically active region and before forming the cover, the optical transparency of the structure having the electrically active region is measured; and

wherein the layer structure is formed depending on the measured optical transparency, such that a desired optical target transparency of the structure having the electrically active region and of the layer structure is obtained.

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 9,130,196 B2
APPLICATION NO. : 14/348906
DATED : September 8, 2015
INVENTOR(S) : Erwin Lang et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the specification
Column 9, line 37: Please delete "(PECVD)" between the words "deposition" and "method", and write "(PLCVD)" in place thereof.

Signed and Sealed this
Nineteenth Day of July, 2016

Michelle K. Lee

Michelle K. Lee
Director of the United States Patent and Trademark Office